2001P05341

4UNE 113

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(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
1 March 2001 (01.03.2001)

PCT

(10) International Publication Number
WO 01/15233 A1

(51) International Patent Classification[7]: H01L 27/00, 51/20, G02F 1/136

(21) International Application Number: PCT/EP00/07877

(22) International Filing Date: 9 August 2000 (09.08.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
99202728.4 24 August 1999 (24.08.1999) EP

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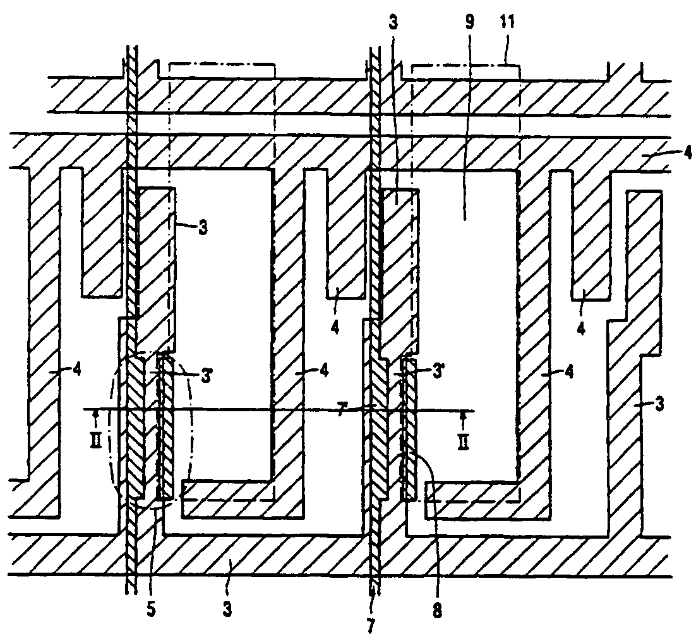
(81) Designated States *(national)*: CN, JP, KR.

(84) Designated States *(regional)*: European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published:
— *With international search report.*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: DISPLAY DEVICE



(57) Abstract: Display device in which switching elements (5) are realized in an organic semiconductor layer. Mutual insulation of the elements and pixels is obtained either electrically by applying depletion via voltages to a guard line (4) or physically by making parts of the organic semiconductor layer insulating.

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least at the area of the switching elements and the picture electrodes, and the display device comprises means for supplying at least one electrode, which, viewed perpendicularly to the substrate, substantially completely surrounds a picture electrode, with such a voltage that layers of organic semiconductor material at the area of switching elements and associated picture electrodes are substantially completely insulated from each other. The electrodes (guard lines) for a plurality of pixels are connected, for example, in an electrically conducting manner to an electrode which surrounds the complete picture surface and which is supplied with such a voltage during use that the semiconductor areas below (or above) the electrodes are insulating. The electrode may also be connected to a gate electrode of a TFT transistor in a matrix display. Since in a matrix of pixels only one row is selected at a time, the semiconductor areas below the gate electrodes are non-conducting during non-selection of the relevant row and constitute the desired insulator. By connecting the electrode to a gate electrode of a field effect transistor for a pixel in an adjacent row, a greater effective pixel surface is obtained.

If desired, said electrode may be provided as a pattern of guard lines underneath the semiconductor layer, with the pattern coinciding, for example, partly with that of the gate electrodes. In that case, the leakage currents are substantially completely eliminated. If necessary, said pattern may function as a black mask. The leakage currents may also be reduced by giving the gate electrode and said electrode meshing comb structures. Also the reverse structure (guard lines above and gate electrodes below the semiconductor layer) is possible.

Another embodiment of a display device according to the invention is characterized in that the layer of organic material comprises organic semiconductor material surrounded by insulating organic material at least at the area of the switching elements. In this case, the insulating organic material is obtained by selectively illuminating a polymer semiconductor material (for example, polythenylene vinylene (PTV)) locally with UV radiation by means of a mask so that it changes into insulating organic material. In this respect, it is to be noted that insulating the channel part for single TFT transistors is described in example 11 of USP 5,854,139.

Since depolarization may occur when using plastic substrates, polarizers are preferably used as substrates. It is alternatively possible to choose electro-optical effects at which no external polarizers are used such as, for example, PDLC.

These and other aspects of the invention are apparent from and will be elucidated with reference to the embodiments described hereinafter.

tin oxide and metal and patterning this layer so that the double layer is maintained at the area of these contacts and electrodes 7, 8, 9. Subsequently, the metal is etched selectively, so that the picture electrodes 9 are free.

In the TFT transistors, the voltage at the gate electrodes determines whether there is conduction or no conduction between source and drain. In this example, with the p-conductivity type of the semiconductor material, the gate area is depleted with a positive voltage at the gate electrodes relative to the source or drain electrodes.

According to the invention, each pixel is substantially completely surrounded by an electrode 4 which, at a sufficiently positive voltage of the gate relative to the source/drain, causes depletion in the superjacent part of the semiconductor material. To this end, the ultimate device of Fig. 2 may be provided with a special voltage source. In this way, the different pixels can be mutually insulated without having to etch the semiconductor structure.

In this example, a black mask 13 which counteracts the influence of incident light on the transistor action is present on the insulating layer 12. Furthermore, the liquid crystal display device comprises a second substrate 16 provided with a counter electrode 17, while in this example the display device is provided in generally known manner with orientation layers 14 and a liquid crystalline material 15 which, if necessary, may be polymerized.

In this example, the picture electrode overlaps the (previous) address line (gate line) with which and with the intermediate insulating material it forms a storage capacitance C_{st} in generally known manner, which may even be increased by providing this above the mask 4.

Although the device may be provided, as usual, with one or more polarizers, a polarizer is preferably used as a substrate so as to prevent depolarizing effects, or an LC effect (or another electro-optical effect) at which no external polarizers are used.

Fig. 3 shows how the metallization pattern (guard line) 4 substantially completely surrounds a picture electrode 9, which is shown diagrammatically, but also reduces the effective pixel surface. Fig. 4 shows an alternative in which the two masks 3, 4 are integrated, as it were. Each guard line is then connected to the previous gate line. In this case, the first row of pixels must be connected to an extra (dummy) line. When a row is being written, a small leakage current may flow for some time to picture electrodes of the subsequent row to be selected. Since this row is written immediately thereafter, at which the voltage on the previous row has a sufficient blocking voltage, this effect, averaged through a

electrodes 3' are formed at the area of juxtaposed source and drain contacts 7, 8. The layer of organic semiconductor material 10 is subsequently converted locally into organic insulating material 21. To this end, the layer 10 is illuminated with UV radiation 22 via a mask 20 (Fig. 10), with the organic semiconducting material 10 becoming insulating at the illuminated areas. The contours of the mask 20 used are denoted by dot-and-dash lines 20 in Fig. 9. In this case, only the area near the TFT transistors is still semiconducting but this is not strictly necessary as long as different TFT transistors are mutually insulated by the insulating parts 21. Other reference numerals in Fig. 11 have the same significance as in Fig. 2.

The invention is of course not limited to the examples shown. For example, reflective display devices may also be realized by starting from non-transparent substrates and by forming the picture electrodes as reflecting electrodes. For example, aluminum is then chosen as a material for the picture electrodes. A double layer is then not necessary for providing the column electrodes 7 (and the source and drain electrodes 7', 8) and the picture electrodes 9.

In summary, the invention relates to a display device based on an active matrix, in which switching elements are formed in a layer of organic semiconductor material, which switching elements are mutually insulated via depletion areas or insulating areas in the same layer of organic semiconductor material.

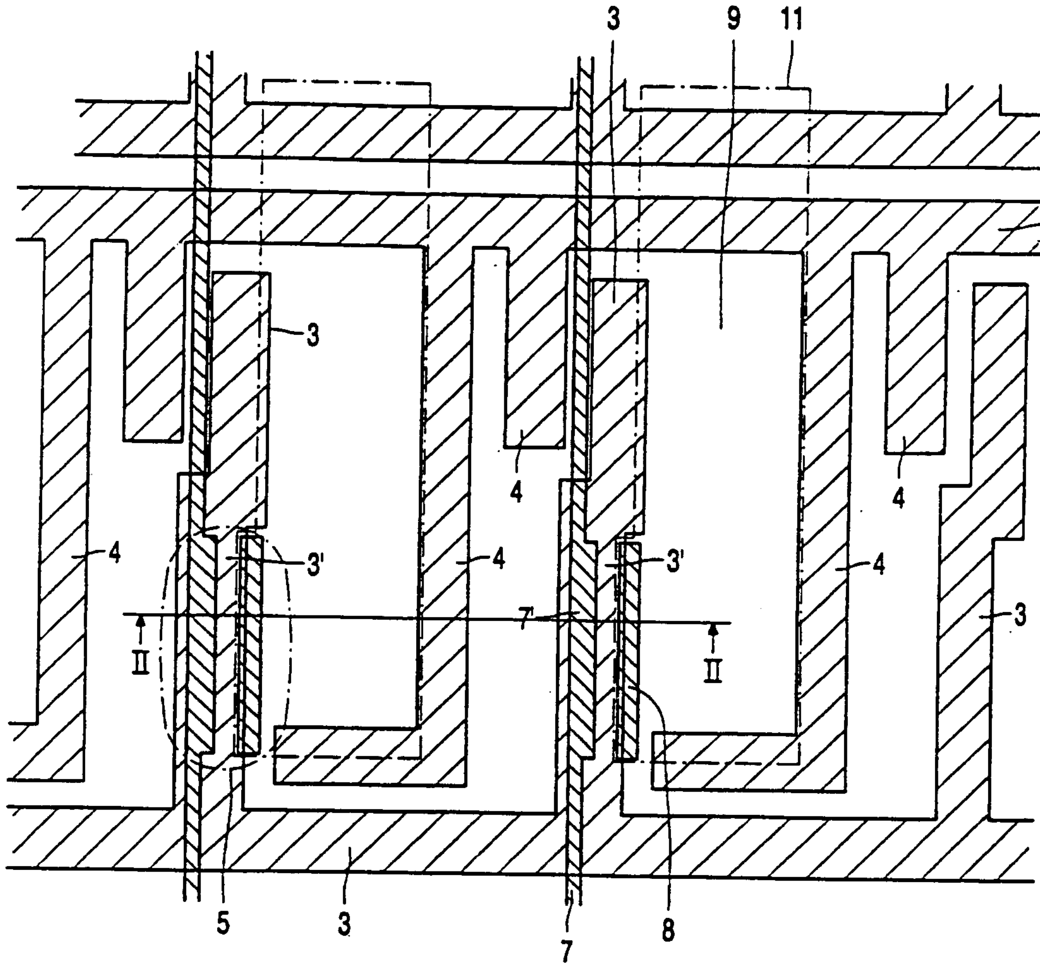
3
9
11
4
3
3
4
4
4
4
3'
3'
4
4
3
7'
II
II
5
3
7
8

FIG. 1

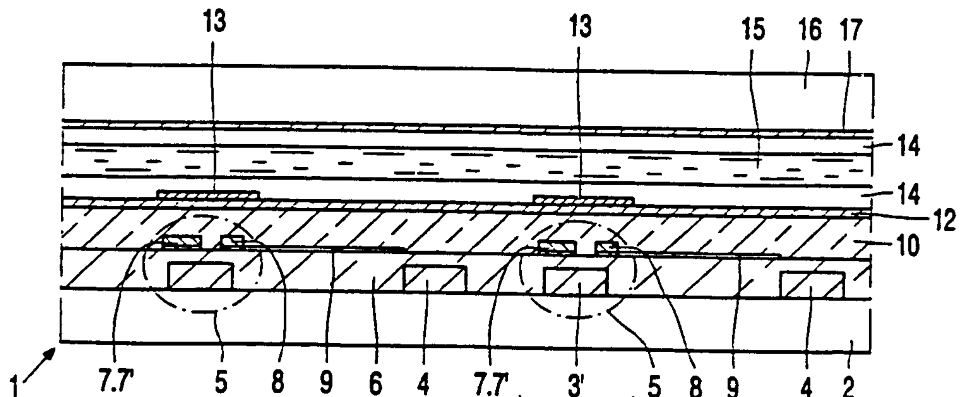
13
13
15
16
17
14
14
12
10
1
7.7'
5
8
9
6
4
7.7'
3'
5
8
9
4
2

FIG. 2

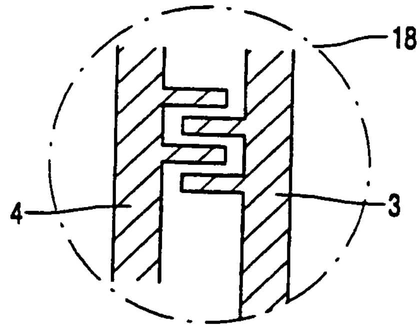

FIG. 5

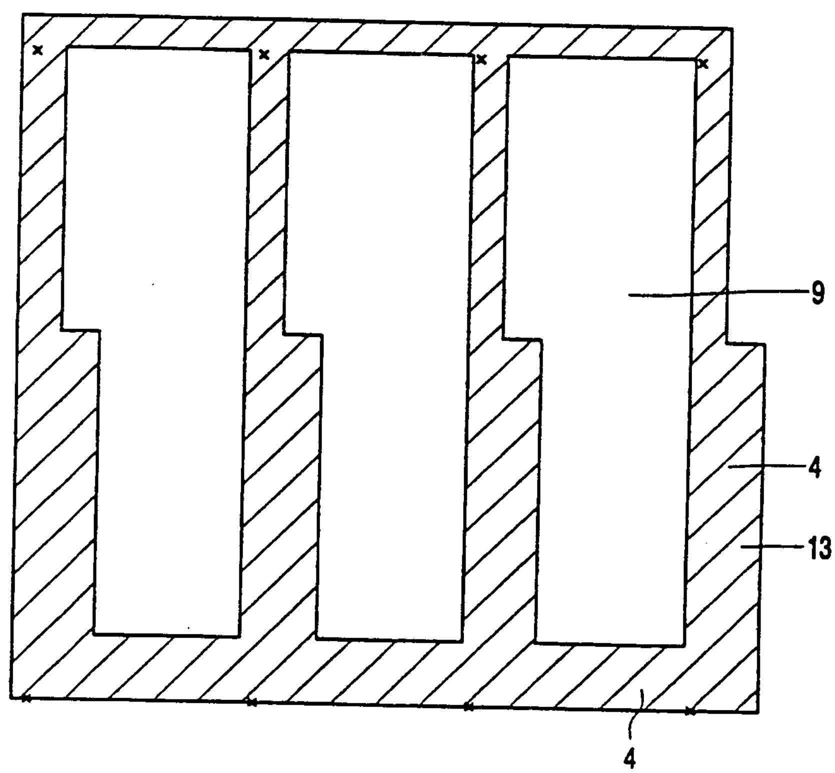

FIG. 6

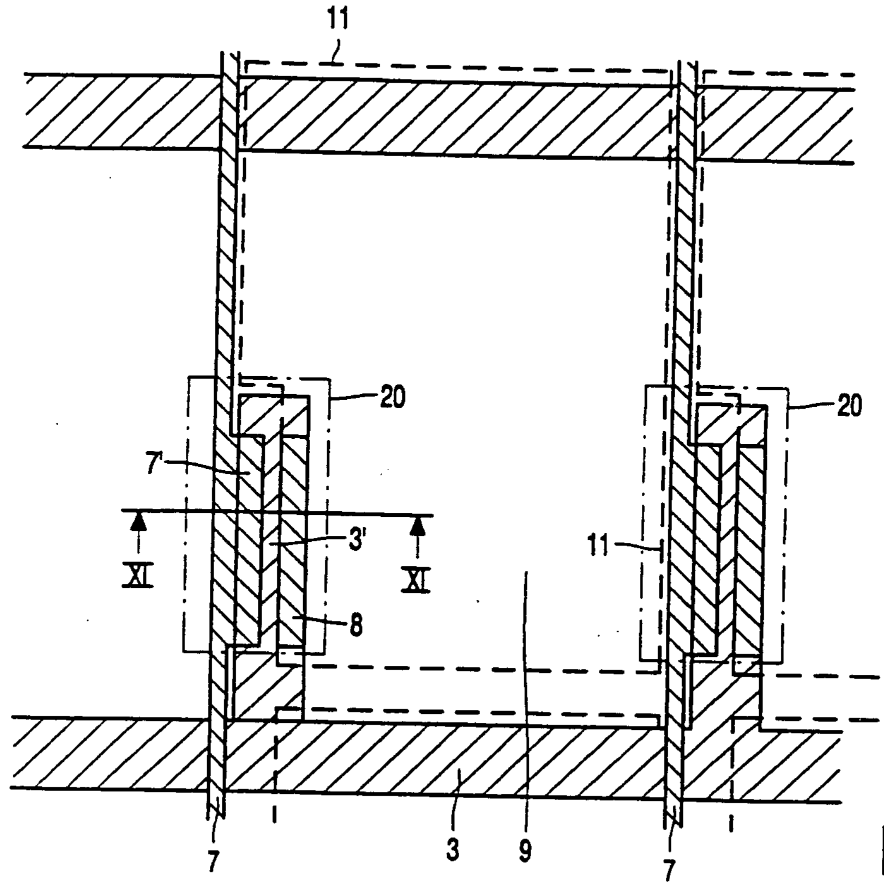

FIG. 9

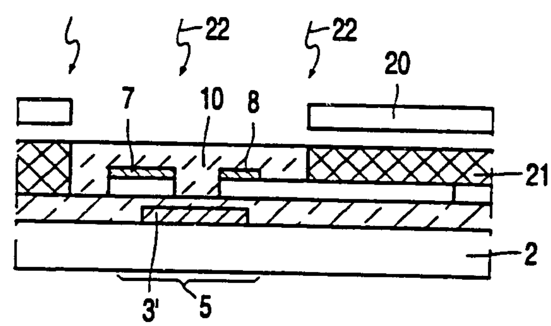

FIG. 10

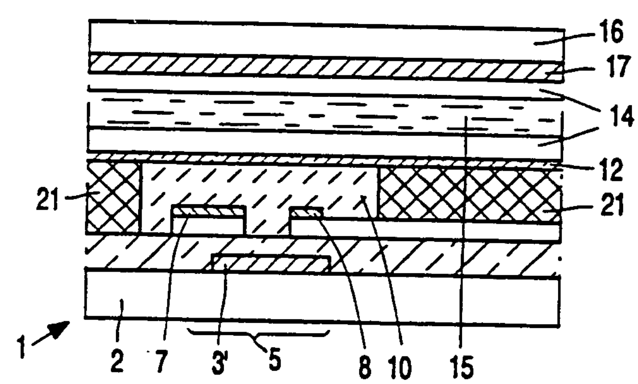

FIG. 11

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 90 08402 A (MITSUBISHI ELECTRIC CORP ;SUMITOMO CHEMICAL CO (JP)) 26 July 1990 (1990-07-26) abstract	1
A	PATENT ABSTRACTS OF JAPAN vol. 016, no. 530 (E-1287), 30 October 1992 (1992-10-30) & JP 04 199638 A (RICOH CO LTD), 20 July 1992 (1992-07-20) abstract	1
A	SIRRINGHAUS H ET AL: "INTEGRATED OPTOELECTRONIC DEVICES BASED ON CONJUGATED POLYMERS" SCIENCE, AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE,,US, vol. 280, 12 June 1998 (1998-06-12), pages 1741-1744, XP000876551 ISSN: 0036-8075 the whole document	